the greater energy of the small battery. In this the number of plates being tenfold gives tenfold intensity, although the aggregate quantity of surface in the whole battery is not $\frac{1}{30}$th part of the acting surfaces in the large battery.

The advantage of a large quantity of fluid is evinced by the long-continued action of the small battery; and it is also observed that in very numerous combinations, a certain distance between the plates becomes necessary to prevent spontaneous discharges, which the author found to take place in a battery of 1250 plates of four inches square.

With this battery of 1250, excited by a fluid of the same strength as was used in the former experiments, the author ascertained the striking distance through the air to be $\frac{1}{50}$th of an inch, care having been taken to dry the air, through which the discharge took place, before the experiment, as well as to avoid any increase of temperature previous to the discharge.

The electric *light* was also made to pass through a vacuum, and was observed to be the same as from a common electrical machine.

The effect of this great number of plates on imperfect conductors, was of course uncommonly powerful, but yet their *power of fusion* was comparatively weak, as they barely melted half an inch of the same platina wire that had been used in the former experiments; and hence it is evident that the construction must be different according to the purpose for which the battery is designed.

For igniting perfect conductors large plates are necessary, but they need not be numerous; and for overcoming the resistance of imperfect conductors number is requisite, but the size of the plates may be small.

The new method of constructing the trough wholly of wood, with moveable plates joined together only at top, is much preferred to the old construction, as the plates are more easily cleaned or repaired, and as they expose double extent of surface.

The Bakerian *Lecture. An Account of some new analytical Researches on the Nature of certain Bodies, particularly the Alkalies, Phosphorus, Sulphur, Carbonaceous Matter, and the Acids hitherto undecompounded; with some general Observations on Chemical Theory. By* Humphry Davy, *Esq. Sec. R.S. F.R.S. Ed. and M.R.I.A.* Read December 15, 1808. [*Phil. Trans.* 1809, *p.* 39.]

The objects which principally occupied Mr. Davy's attention in the present lecture are, the elements of ammonia; the nature of sulphur; the nature of phosphorus; the states of the carbonaceous principle in plumbago, charcoal, and diamond; the analysis of boracic acid; the analysis of fluoric acid; with a series of numerous experiments on muriatic acid.

With respect to ammonia, he has been induced to reconsider the subject, not from any doubt which he himself entertained of the correctness of his former results, but on account of the opinion still

maintained by Messrs. Berthollet on the non-existence of oxygen in ammonia, and on account of the inference deduced by Messrs. Gay-Lussac and Thenard, from the action of potassium on ammonia, who conclude that potassium is a compound of potash and hydrogen. Mr. Davy consequently details a variety of processes in which he examined all the circumstances and results of their mutual action.

The potassium employed was procured by passing dry potash through red-hot iron turnings in a gun-barrel, which appears to differ from that obtained by electricity solely in containing a very small portion of iron.

A green glass retort, after the introduction of a piece of potassium, is first exhausted, then filled with ammoniacal gas, and after two subsequent exhaustions, finally filled again with the gas in an extremely pure state. The potassium thus exposed to ammonia at common temperatures, loses its lustre and becomes white by a thin crust of potash on its surface; while the gas suffers a slight diminution, and then contains about $\frac{1}{30}$th of its bulk of hydrogen.

When the potassium is heated by a spirit-lamp, the colour changes from white to a bright azure, thence to bright blue, green, and olive, which is the last state to which the whole of the potassium may be brought by continuation of the heat. When sufficient ammonia is present to insure the complete saturation of eight grains of potassium, twelve cubic inches of ammoniacal gas disappear, and nearly eight cubic inches of hydrogen are evolved. The French chemist having stated this quantity to be exactly equal to that given out by the action of an equal quantity of potassium on water, Mr. Davy has made the comparison with great care, and finds the quantity of hydrogen given out by its action upon water to be just $8\frac{1}{2}$ cubic inches.

The olive-coloured compound formed is combustible, heavier than water, and a conductor of electricity. It fuses at a low temperature, and then begins to emit ammonia, till its quantity amounts to $4\frac{3}{4}$ inches out of 12 cubic inches that had disappeared. The residuum is then no longer fluid, and begins to give off hydrogen and nitrogen, till the former amounts to 4 inches and the latter to $1\frac{6}{10}$, in proportion exactly suited to the formation of ammonia. When this residuum no longer yields any gas, even at a red heat, a quantity of ammonia may still be formed from it by the addition of water, and amounting to about four cubical inches, and along with these about $\frac{1}{20}$th of an inch of hydrogen. The formation of *ammonia* in this case having proved that a quantity of nitrogen was here combined with the potassium, other experiments were instituted for the purpose of obtaining it separate. By combustion in oxygen gas, a part of the nitrogen, but not the whole, was obtained; but by distillation with red oxide of mercury, the product of nitrogen was greater. For the formation of *ammonia* from this nitrogen, as much hydrogen is wanted as was originally given out by the ammonia, in the first part of the action of potassium upon it; but unless *oxygen*, as well as hydrogen, be sup-

plied, neither potash nor ammonia can be produced; and if oxygen merely be applied, potash and nitrogen are the result.

In consequence of the supposition of Messrs. Gay-Lussac and Thenard, that they had formed a compound of potassium and hydrogen, Mr. Davy repeated their experiment frequently, without any success; neither has he, by any other means, been able to form a compound of hydrogen with potassium.

In the residuum obtained by heat, after the action of potassium on ammonia, the nitrogen appears to be combined with an oxide of potassium, in which the oxygen amounts to about three per cent. By greater heat this compound itself sublimes, and does not yield nitrogen without the intervention of oxygen; as if some portion of the latter were essential to the constitution of nitrogen gas.

Mr. Davy refers to an hypothesis formerly advanced, that all metals may possibly be compounds of unknown bases with hydrogen; but replies to those arguments by which Messrs. Gay-Lussac and Thenard imagined that they had proved the existence of hydrogen in potassium; for which there appears to be no foundation in fact. Until hydrogen can be separated from some metallic substance,—until a metal can be deprived of its imflammability by the separation of hydrogen, that theory must be preferred, which, in explaining all the facts, admits the presence of no ponderable agents of which the existence cannot be proved.

Mr. Davy next proceeds to an examination of sulphur, first by passing discharges through it in a fluid state from a common electric machine, but afterwards with better success by the voltaic battery, and obtained gas from it in sufficient quantity to ascertain that the gas consists wholly of sulphuretted hydrogen. In the course of the process, the sulphur had acquired the power of reddening litmus. After long-continued electrization, the sulphur became extremely difficult of fusion and acquired a dirty brown colour.

By the action of potassium on sulphur, sulphuretted hydrogen is also evolved with intense heat and light; and the circumstances of this operation appear to be similar to what occurs when potassium is heated in contact with resin, camphor, wax, and fixed oils, in close vessels. For in this case also, great heat is generated, and great quantities of carburetted hydrogen evolved. In addition to this analogy in their chemical actions, Mr. Davy also remarks, that the physical qualities of these bodies resemble those of sulphur.

They agree in being non-conductors, whether fluid or solid; transparent when fluid, but semi-transparent when solid, and highly refractive; but resinous and oily bodies contain a small quantity of hydrogen and oxygen, with a large quantity of carbonaceous matter. So also in sulphur, the mixture of hydrogen is fully proved, and the existence of oxygen might be inferred from the effect of the residual sulphur on litmus paper, but is more distinctly evinced by the formation of potash when potassium is heated in sulphuretted hydrogen. From such experiments as were most to be depended upon, it

is inferred that the quantity of oxygen in sulphur amounts to about ten per cent., and hence the intense ignition that occurs in the union of sulphur with potassium, and other metallic bodies, is traced to a more probable source than their mere affinity for sulphur.

The same analogies apply to phosphorus as to sulphur; the same mode of operating was adopted, and products perfectly analogous were obtained. By electrization, phosphuretted hydrogen was given out, and the phosphorus became of a deep red brown colour. By the action of potassium also, phosphuretted hydrogen was obtained, and by the action of acids on the residuum, it appeared that the potassium had gained oxygen from the phosphorus; and the same inference is drawn from the action of potassium on phosphuretted hydrogen, which appears to contain oxygen in a state of combination, similar to that which obtains in sulphuretted hydrogen.

The same new modes of research are next employed to discover what differences subsist in the states of carbonaceous matter, in plumbago, charcoal, and diamond; for though late and very accurate experiments have proved that they yield very nearly the same quantities of carbonic acid, it was nevertheless not improbable that new means of analysis might detect chemical differences, correspondent to the extreme difference of their physical properties.

Plumbago, whether acted upon by the voltaic battery or by potassium, yields no elastic product in either case; but in the latter, merely combines with the potassium unaltered. Charcoal, on the contrary, by the voltaic apparatus, yielded a considerable quantity of carburetted hydrogen, but did not contribute to the oxidation of the potassium, any more than plumbago had done.

The unconducting nature of the diamond rendered it impossible to apply the voltaic battery with any effect, but it was by no means insensible to the action of potassium. When these substances were heated together, there was no intensity of action, and no production of elastic fluid. But the diamond soon blackened at its surface, and was ultimately reduced to a state perfectly resembling plumbago; part of it at the same time uniting to the potassium. The addition of carbonaceous matter was not, however, the sole change that had happened to the potassium, as it now extricated a smaller quantity of hydrogen from water than an equal quantity of pure potassium, and had evidently acquired a portion of oxygen from the diamond. This quantity of oxygen (though certainly very small) is thought to be the cause of its non-conducting quality.

Mr. Davy next resumes the analysis of boracic acid, which he had begun in his last Bakerian Lecture. By means of voltaic electricity, a black matter could be obtained from it that was unaltered by water, but soluble in nitric acid, and when heated to redness, burned slowly, giving off white fumes. But the quantity of the base that could be thus obtained was too minute for determining distinctly its relation to the acid from which it was produced. However, by heating together boracic acid with potassium, a large quantity of a similar matter (as has also been observed by M. Thenard) was obtained. In

this experiment intense ignition took place at the point of contact of the substances, the potassium appearing to burn by oxygen acquired from the acid, of which eight grains saturated about twenty of potassium.

The residuum did not effervesce in water, which merely dissolved some sub-borate of potash which is formed, and leaves exposed the boracic base as a spongy mass, black in some parts, and dark olive in others. It appeared to be infusible by heat, but a perfect conductor of electricity. When acted upon by nitric acid, or burned in oxygen, it was reduced again to the state of boracic acid, probably much heavier than the basis from which it is formed.

When fluoric acid gas was acted on by potassium, fourteen cubic inches disappeared by means of ten grains and a half of potassium, and about two inches and a quarter of hydrogen gas were evolved, apparently from water contained in the gas. In this experiment, a brownish sublimate was sometimes raised by the heat generated, and at others, a blackish matter remained mixed with a quantity of fluate of potash that is formed.

This matter appears to be fluoric acid, deprived of oxygen, and existing in a state analogous to that of sulphur and phosphorus; for when the sulphuric or phosphoric acids are decomposed by potassium, the pure bases are not evolved, but sulphurets and sulphites, phosphorets and phosphites, are generated.

Although the attempts to decompose the muriatic acid have not hitherto been equally successful with the preceding, yet many new and interesting results were obtained. When a quantity of potassium was employed, sufficient to absorb a given quantity of this gas, so much hydrogen was evolved as to prove that it contains full one third its weight of water.

Various attempts were made in consequence, to obtain the acid free from water, but they only terminated in new and singular combinations.

By burning phosphorus in oxymuriatic acid, a very volatile compound was obtained, consisting, apparently, of muriatic acid and phosphoric acid in a dry state, and a second compound of phosphorous acid with muriatic also, free from water. Corresponding products were also obtained by means of sulphur, consisting of dry sulphuric and muriatic acids; and the most remarkable circumstance attending these compounds, is, that they do not redden litmus paper, and manifest no marks of acidity till water is added to them.

In exposing potassium to these compounds, a violent detonation takes place, and Mr. Davy has some reason to hope that the muriatic acid suffers decomposition at the time, but he has not yet been able to collect the products for examination; and the elements of this acid, if separable, must remain a subject for future investigation.